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SINGLE CHANNEL GROUND AND AIRBORNE RADIO SYSTEM (SINCGARS)
BASIC OPERATOR TRAINING EVALUATION

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June 1988

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SINCGARS FOLLOW-ON TEST & EVALUATION

Issue 6:

"Does the training provide necessary knowledge and skills to operate and maintain the SINCGARS radio system?"

SINCGARS Basic Operator Training Evaluation

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CONTENTS

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Basic Operator Training

The basic operator net-outstation training course for the SINCGARS Follow-On Test & Evaluation (FOT&E) consisted of a 40-hour block of instruction and testing conducted over five days. Sixteen classes were taught over a one month period that commenced on 29 February 1988. During each week, two classes were conducted during the day and two at night (1730 to 0230 hours), in two classrooms.

The two classrooms were very similar. Both were prepared to accommodate approximately 25 students at a time with two students per radio. There were 12 different instructors, 3 per class. The total number of students taught during the month was 376--an average of 23.5 students per classroom. The actual number of students in a classroom varied, however, from 11 to 42, as shown in Table 1.

Table 1
Training Groups

Course	Week	Shift	Class #	Class Size
1.	1	D	1	26
2.	1	D	2	26
3.	1	N	1	21
4.	1	N	2	24
5.	2	D	1	22
6.	2	D	2	26
7.	2	N	1	24
8.	2	N	2	26
9.	3	D	1	25
10.	3	D	2	26
11.	3	N	1	11
12.	3	N	2	11
13.	4	D	1	42
14.	4	D	2	17
15.	4	N	1	26
16.	4	N	2	14
			Total:	367

Tables 2a through 2c present descriptive personal data about the students.

Table 2a
Student Body Descriptors: Rank

Rank	Frequency	Percent[a]
PV1	2	<1
PV2	62	20
PFC	26	8
CPL/SP4	134	43
SGT	42	14
SSG	32	10
SFC	12	4
---[b]	57	..
Total:	310	

[a]Percent of available data. Available = 376 minus missing data.
[b]Missing data.

Table 2b
Student Body Descriptors: Primary MOS

MOS	Frequency	Percent[a]	MOS	Frequency	Percent[a]
11B	32	10	21G	7	2
11C	39	13	31K	10	3
13B	40	13	63B	5	2
13E	15	5	63Y	4	1
13F	41	13	76C	5	2
13N	11	4	76Y	9	3
15E	19	6	88M	5	2
19D	4	1	Misc.[b]	42	14
19E	18	6	---[c]	6	..
Total:				306	

[a]Percent of available data. Available = 376 minus missing data.
[b]Miscellaneous MOSs: Sum of MOSs that each composed less than 1% of the available MOSs (N = 306).
[c]Missing data.

Table 2c
Student body descriptors: ASVAB* Scores

Score	Mean
Electronics Repair (EL)	105.7
General Technical (GT)	106.2
Surveillence & Communications (SC)	107.6

*Armed Services Vocational Aptitude Battery

Evaluation Methodology

Two of the four weeks of basic operator training were observed by a training evaluator from the Army Research Institute who recorded on a real-time basis the flow of events in the observed classes.

One of the objectives of the evaluation was to determine the efficiency of the instruction in terms of the amount of unused time. The efficiency analysis is described in detail below.

A second objective of the evaluation was to ascertain the amount of time required for trained students to perform the critical tasks involved in operating the SINCGARS radio and to relate this information to other variables, such as selected Armed Services Vocational Aptitude Battery (ASVAB) scores (see Table 2c) and performance on the SINCGARS Learning-Retention Test (SLRT), a simulated hands-on performance test. The ASVAB EL score reflects the student's facility in arithmetic reasoning, math knowledge, electronics information, and general science. The ASVAB GT score reflects a verbal composite and arithmetic reasoning. The ASVAB SC score concerns numerical operations, coding speed, auto and shop information, and the verbal composite. The students' ASVAB scores were obtained from unit files.

The SLRT was administered to all students in all 16 classes immediately following their final examinations ("Criterion Test") by the class instructors.

A third objective of the evaluation was to assess student reactions to the training. This was accomplished in two ways: (a) through direct observation of student participation by the evaluator and (b) by the administration of a post-training questionnaire that asked students to provide comments pertaining to course improvement. This questionnaire, the Training Evaluation Questionnaire for Operators (TEQO), was administered to all students following the administration of the SLRT.

Gross Instructional Efficiency Analysis

The purpose of this analysis was to obtain an accurate estimate of how efficiently the basic SINCGARS operator course used student manhours. (The

basic course did not include formal net-control-station training and retransmission training. Those topics were taught separately and were not observed for this evaluation.) The term "gross" is applied to this analysis to emphasize that the only time periods counted as inefficient for any student were those during which the student was, for purposes of the course, virtually idle--i.e., engaged in no learning-related activity.

On the other hand, it is recognized that a certain amount of inefficiency, as here defined, is inherent in any course of instruction. Therefore, the objective of the analysis is not to imply that every wasted manhour can be eliminated but to provide a background against which future course improvements can be made.

Observational procedure. One of the 16 courses (4th week, day shift, class 1) was observed in its entirety and comprises the basis for this analysis. At regular intervals (often as short as one minute) the course evaluator observed and recorded the number of students who were completely idle (engaged in no course-related learning activity, either active or passive). If it was not patently obvious that a student was idle, the observation was not so counted.

Similar observations were made of the class instructors. At any given time, one of the three instructors was in charge of the class, while the other two assisted as requested or as they saw fit. The time spent by the instructor who was actually conducting the class at any given moment was never counted as inefficient, regardless of how effective or ineffective the instruction might have been. However, a close accounting was made of the extent to which the two assisting instructors participated in the ongoing instructional activities. As in the analysis of student participation, the only time counted as inefficient was that during which there was no discernable instruction-related effort.

Nominal course description. The course ran for four days, not including post-training testing, which was conducted on the fifth day. The total number of scheduled course hours, including lunch and study breaks, was 34. The total number of scheduled instructional hours (which excludes breaks) was 22 (5.5 hours per day). Daily sessions extended from 0800 hours to 1630 hours with four 20-minute study breaks (two in the morning and two in the afternoon) and a lunch break of one hour, forty minutes (from 1130 to 1310 hours). There were 3 instructors, 42 students, 13 radios, 13 operator's manuals (10-1), and 13 operator's pocket manuals (10-2).

Actual course description. Table 3 compares the nominal course description to the actual course. It shows that the actual distribution of major time components during the course was substantially as planned.

Table 3
Actual versus Nominal Course Parameters*

Day	Instruction (5.50)	Lunch Breaks (1.67)	Study Breaks (1.33)	Total (8.50)
1	5.6	1.7	1.3	8.5
2	5.5	1.7	1.4	8.5
3	5.6	1.5	1.4	8.5
4	5.2	1.7	1.6	8.5
Total:	21.9 (22.0)	6.6 (6.7)	5.7 (5.3)	34.0 (34.0)

*All figures are hours. Nominal values are given in parentheses.

<u>Efficiency results for students</u>. Table 4 portrays the percentages of idle hours during all half-day course segments. Two strong trends are immediately apparent: The number of idle student hours increased (a) from morning to afternoon on each of the four days and (b) from Day 1 through Day 4 for both morning and afternoon sessions. Indicative of the strong increases in idleness as the course progressed is the fact that the percentages for mornings 2, 3, and 4 were each higher than the overall percentage for the previous day.

Table 4
Percentages of Idle Student Hours

Day	Morning (%)	Afternoon (%)	Overall* (%)
1	6.7	21.5	13.7
2	14.8	22.6	18.4
3	19.0	43.7	31.6
4	47.6	58.8	51.3
Overall:	22.0	36.7	28.8

*Calculated from morning and afternoon figures weighted by amount of time observed.

Table 5 is based upon the distinction between "classroom time" and "consumed time." Classroom time is simply the instructional time provided--literally the amount of time the students spent in the classroom. Consumed time is the amount of student time during which at least minimal learning activity was observed. The table shows the effect of subtracting idle student time (i.e., unconsumed time) from the actual instructional time.

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Table 6
Percentages of Unused Instructor Hours[a]

Day	Morning (%)	Afternoon (%)	Overall[b] (%)
1	58.5	63.9	61.1
2	75.3	76.6	75.9
3	39.8	36.1	38.0
4	(- - - - - - -	Unrecorded	- - - - - - -)
Overall[c]:	58.3	59.4	58.8

[a]Data are for the two assisting instructors.
[b]Calculated from morning and afternoon figures weighted by amount of time observed.
[c]First three days only.

Like the pattern for students, the pattern for assisting instructors showed an increase from day 1 to day 2. The third day, however, consisted of a great amount of loosely structured and unstructured student practice, during which the instructors often mingled with the students to answer their questions, solve equipment problems, etc. Day 4 was similar to day 3, although perhaps even less structured.

Table 7 expresses the results for assisting instructors in terms of the amount of instructor time that involved at least minimal instructional activity, irrespective of its extent or effectiveness. It is evident from the table that over 40 percent of the assisting instructors time was not utilized. As was true for the student data, these data are very conservative. Forty percent nonutilization underestimates by an undetermined (but probably substantial) amount the percentage of time that was not utilized optimally. Furthermore, it is likely that instructor utilization would be even less efficient in smaller classes, where it is expected there would be less demand for their services. This hypothesis would, however, have to be tested.

Table 7
Instructional Hours Utilized
by Assisting Instructors

Day	Hours Used	Percent of Available[a]
1	6.7	61.1
2	8.4	75.9
3	4.2	38.0
4	(Unrecorded)	n/a
Overall[b]:	19.3	58.5

[a]11 hours available per day (5.5 hours per instructor).
[b]First three days only.

Operator Evaluation of Training

A questionnaire entitled "Training Evaluation Questionnaire for Operators" (TEQO) was administered to all students in all 16 classes at the end of their training. The questionnaire asked them to rate the training associated with each critical operational task on two five-point scales: (a) The first scale asked how confusing the training was, especially during the earlier part of the course; the scale ranged from "Not confusing" (1) to "Very confusing" (5); (b) the second scale asked whether each task could have been learned faster had the training been different in some way; it ranged from "No" (1) to "Very much faster" (5).

The TEQO also asked the students to describe what they thought should be added to or eliminated from the course to make it more efficient, effective, or better.

TEQO Results: rating scales. The rating scales indicated, in general, that the students perceived the critical tasks to be neither confusing to learn nor capable of being learned a great deal faster. The mean scores for the critical tasks (calculated across all students) ranged from 1.1 to 2.0 for the "confusion" scale and from 1.7 to 2.2 for the "faster" scale. There is a danger of misinterpreting these results, however. It was amply evident from the results to be described in the next section that the students felt the course was too long, and they offered many comments related to confusion and related topics. The appropriate interpretation of the results at hand is probably that the course content itself, irrespective of the conduct of the course, was not overly difficult and that it was capable of being learned in a reasonable amount of time, irrespective of the amount of time devoted to the course.

TEQO Results: student comments. The students offered many pertinent and useful comments. They have been accurately paraphrased, organized to categories, and summarized in tables. Each table is devoted to a different

category of comments. The right column of each table gives the frequency with which each type of comment within the category was made. The frequencies should be taken into account in evaluating the comments--although, the frequency is often unrelated to the value of the comment. It is not unusual that a comment made by a single respondent is quite useful.

Table 8a
Student Comments about Course Content

Comment Summary	Frequency
1. There needs to be more complete coverage of SINCGARS topics, including NCS procedures, installation & assembly/disassembly procedures, system configurations, PMCS, remote operations, TACFIRE operations, retransmission, data transmission, cueing, hazards, & maintenance procedures.	24
2. Instructors should not assume prior knowledge or experience in students. Provide a more basic introduction & overview that includes some basic radio operation procedures, coverage of technical terms with which inexperienced students may be unfamiliar, & an introductory overview of the manual.	13
3. More attention needs to be paid to the "why" of procedures in order to aid retention. Give better explanations, more "theory," less rote learning.	11
4. Training on the KY-57 should occur elsewhere, not in the SINCGARS operator class.	4
5. Place more emphasis on the correct order of steps in the various operational procedures. [Evaluator comment: This is desirable in order to overcome the sometimes inconsistent or unobvious steps that must be followed for some tasks.]	2

Table 8b
Student Comments about Instructional Methods

Comment Summary	Frequency
1. Provide more radios (i.e. a higher radio-to-student ratio). One radio per person.	36
2. Instruction should be more individualized, with an opportunity for some self-pacing. Some students require more work on some topics than others. There should be a higher instructor-to-student ratio. One student remarked: "Make the class self-paced instead of lock step. So much time was spent just going over & over things that the majority of the class [already knew], it became redundant and ended up more like a detention hall than a classroom."	26
3. The course should be more realistic in the sense of providing a more field-like environment: more nets, more NCSs, more separation among the radios, real antennas, CEOIs. Conduct some training with NCS operators in another room to prevent ordinary verbal communication among station operators.	25
4. The class should be better disciplined with less commotion, less wasted time, & more structure. Rotating students for hands-on practice (while others wait) is a waste of time. There should be less "filler" material in the lectures.	20
5. Classes should be smaller. Use assisting instructors in separate, smaller classes. (Sometimes the instructors have competing interests, objectives, or methods.)	8
6. Night classes should be eliminated or made shorter.	8
7. There should be more frequent testing (of a structured nature) followed by remedial practice time.	7
8. The upper & lower ranks should be separated into separate classes. Separate officers from enlisted & upper-ranking enlisted from lower-ranking enlisted. ["First two days, the captain hogged RT & did everything."]	3

[Table continued on next page]

Table 8b, continued
Student Comments about Instructional Methods

Comment Summary	Frequency
9. Miscellaneous:	
a. The class needs to be more interesting: "We played competition games [with the radio] for a time. That made it interesting, fun, & easier to understand & hold the information taught."	2
b. Some students acted as NCSs, others did not get a chance--"those who didn't get to be NCS missed out on a lot."	2
c. The class should only be for communications people from the units. Once they are taught, they can teach the rest of the unit.	2
d. Class rules should be less childish & students should receive less childish treatment.	2
e. The course should start with a taste of hands-on. Students felt a little frustrated waiting.	1
f. Students were not given adequate advance notice of scheduling for SINCGARS training. This caused inconvenience in having to change personal plans at last minute.	1

Table 8c
Student Comments about Allocation of Course Time

Comment Summary	Frequency
1. The course is too long. Could be cut by one or more days. Material is too repetitive. [E.g., "The last two days were spent doing almost nothing."]	89
2. There should be more structured [as opposed to free-play] hands-on time. Less lecture time.	26
3. The course should be longer. [Evaluator comment: Considering the strong evidence that the course should be shorter, this comment may need to be viewed within that context. The students seemed to be expressing the feeling of not being familiar enough with the material despite the length of the course. This may reflect more strongly on the effectiveness, or quality, of the course rather than its length.]	12
4. Miscellaneous:	
a. Breaks should be shorter or fewer.	5
b. The pace was too fast. Students were rushed.	3
c. Too much time was wasted on simplistic matters.	1
d. The main instructor spends too much time with individual students at the cost of the others.	1

Table 8d
Student Comments about Manuals and Instructional Aids

Comment Summary	Frequency
1. The Operator's Manual (TM 11-5820-890-10-1, 1 MAR 88) needs to be improved: needs to be better organized, to have better separation of sections ["could not tell when section changed"], better arrangement & spacing of material, & clearer step-by-step directions, etc. One student commented: "The 10-1 . . . manual needs to be rewritten [so the student can] understand more about the components. Instead of referring to different pages or the components' model numbers, the components need names. The 10-1 can be written in steps on how the SINCGARS works without reference to different pages or other TM."	17
2. Give all students a manual for reference & home study: "Didn't have an opportunity to use manual"; "never read manual"; "more manuals"; (etc.).	16
3. Need training films & more diagrams & illustrations. Use a large model or mockup of the radio so students can see the settings & follow procedures. There should be large charts at the front of the room that show the steps for each operation.	10
4. Provide handouts describing operational procedures (the manual doesn't help enough). Need a course notebook or syllabus to follow & use for reference. Shouldn't rely on student notes.	6
5. Miscellaneous:	
a. The manuals need to be used more in class.	2
b. The pocket manual (TM 11-5820-890-10-2) needs to be improved. Needs to be made out of plastic.	2
c. The 10-1 & 10-2 manuals need to be combined: "Combine them so the soldier will never be confused [about] where to look for something."	1
d. The manual (& training) should put more emphasis on the fact that the radio should not be operated with the power amplifier unless the vehicle engine is running [see Operator's Manual, p. 2-32].	1

Table 8e
Student Comments about Instructors

Comment Summary	Frequency
1. Instructors need more complete knowledge of system.	8
2. More than one instructor in the room sometimes creates conflicts among them. The assisting instructors may interrupt the instructor in charge.	2
3. Need military instructors, not civilian.	2

Table 8f
Miscellaneous Student Comments about Human-Factors Issues

Comment Summary	Frequency
1. The W2 RF cable is hard to install & is designed poorly.	2
2. The radios should be raised or angled upward in the classroom to make it easier for students to view the display & controls.	1
3. The radio needs a speaker or headsets.	1
4. The radio is too complicated.	1
5. The front panel needs a protective cover for field use.	1
6. The cue signal should be received only by radios set on FH/M.	
7. The +4 to -4 "window" for time is not large enough.	1
8. Time should not be destroyed by Z-A. The radio should have a permanent real-time clock with its own battery.	1

Post-Training Testing: Criterion Test (Final Exam)

At the end of the 40-hour block of basic operator training, all students were given two performance tests. The first of these, referred to as the

Criterion Test, was part of the official TRADOC training materials and was administered by the instructors on a one-on-one basis. On the average, the test required about 25 minutes to complete. Actual administration times varied from student to student as a function both of the skill of the student and the administrative style of the instructor (some instructors conducted the procedure faster than others).

The test itself consisted of 18 hands-on performance tasks. Each task was to be completed by the student in a prescribed amount of time and scored as a "go" or a "no go." The time limits, or criteria, were selected by training supervisors who based them on their estimates of the amount of time required for the slowest students to accomplish the tasks. Thus the time intervals allowed ample time for completing the tasks. The test, designed for screening out only those who exhibited very extreme performance shortcomings, allowed approximately 99 percent of the students to pass the course. It is not feasible that all students would be able to complete all of the critical tasks on the Criterion Test without errors and without a trial-and-error approach to task accomplishment, and it is assumed that this occurred. It was observed in some instances that some of the instructors would provide corrective feedback to students during the testing. In this regard it is noted that the practice of occasionally assisting the student who cannot proceed with the test because of a fatal error, does not violate the objectives of the testing so long as the instructor takes account of students who are essentially incapable of performing even at a minimal level.

Owing to the "go/no-go" nature of the scoring and the liberal time limits, the Criterion Test was not capable of making distinctions among students (i.e., it did not measure any dimension of performance quality). Therefore, ARI requested that individual student performances on each of the 18 criterion tasks be timed and that students who failed to perform a task within the prescribed criterion time be allowed to continue until the task was completed or it became obvious that the student was essentially incapable of performing the task. Although the suggestion met with some resistance from some of the instructors because of the increased investment of time in post-training testing, the suggested procedure was followed. The administering instructors timed each task performance with a stopwatch and recorded the times on the Criterion Test scoring sheets. Task performance time thus became available for use as a criterion variable in the current training evaluation; the times also constitute an objective basis for selecting future test criteria.

<u>Detailed description of SINCGARS operator performance tasks</u>. Table 9 provides a detailed breakdown of the 18 critical tasks performed by the trainees on the Criterion Test. It serves to describe much of what the SINCGARS trainee must learn in order to operate the radio as an outstation net member. It also illustrates the nature of the basic operator course content.

Table 9

Components of Criterion Tasks

Task 1: Assemble the SINCGARS AN/VRC-90 radio set:

a. Connect VINSON (TSEC/KY-57) cable CX-13293/VRC to receiver-transmitter (RT) RT-1439/VRC.
b. Snake CX-13293/VRC through RT mounting adapter AM-7239/VRC.
c. Slide RT into adapter & seat it.
d. Tighten left & right holding screws.
e. Connect W2 cable from antenna connector to power amplifier J2 connector.
f. Connect W4 cable from J5 connector on mounting adapter to AUD/DATA connector on RT.
g. Connect cable from J5 connector on RT to VINSON.
h. Connect handset H-250/U to J3 connector on mounting adapter.

Task 2: Turn on & test RT:

a. Move function switch from "STW" position to "Z-A" position.
b. Observe "good" (or fail message) in display.
c. Move function switch to TST position.
d. Observe "E...d" & "88888" in display; listen for tone & clicks, & observe "good" in display.
e. Turn function switch to "SQ ON" position.

Task 3: Turn on, clear, & load TSEC/KY-57 (VINSON):

a. Turn on VINSON.
b. Turn MODE switch to "C" position.
c. Key H-250/U to clear tone.
d. Turn function switch to "LD" position.
e. Connect KYK-13 fill device to VINSON.
f. Turn on KYK-13.
g. Turn KYK-13 switch to position 1.
h. Turn VINSON switch to position 1.
i. Key H-250/U, observe KYK-13 for light blink, & and listen for beep in handset.
j. Turn off KYK-13 & disconnect.

Task 4: Set battery condition in RT:

a. Set RT function switch to "LD."
b. Press "BATT CALL" & observe "00" in display.
c. Press "CLR" & observe "__" in display.
d. Key in the status numbers found on battery.
e. Press "Sto/ENT" & observe blink in display.

[Table continued on next page]

Table 9, continued
Components of Criterion Tasks

Task 5: Load manual, cue, & two single-channel frequencies into RT:

a. Set function switch to "LD."
b. With channel switch in "MAN" position, press "FREQ," "CLR," & numbers of desired frequency.
c. Press "Sto/ENT" & observe blink in display.
d. Turn channel switch to "CUE," press "FREQ," "CLR," & numbers of desired frequency.
e. Press "Sto/ENT" & observe blink in display.
f. Set channel switch to channel 1, press "FREQ," "CLR" & numbers of desired frequency.
g. Press "Sto/ENT" & observe blink in display.
h. Set channel switch to channel 2, press "FREQ," "CLR," & numbers of desired frequency.
i. Press "Sto/ENT" & observe blink in display.

Task 6: Perform communications check on manual channel:

a. Set function switch to "SQ ON."
b. Set mode switch to "SC."
c. Set channel switch to "MAN."
d. Depress P-T-T switch on H-250/U & talk to NCS.

Task 7: Set frequency offset on one channel:

a. Set channel switch to desired channel & observe frequency in display.
b. Press "SEnd/OFST" & observe "00" in display.
c. Press "CLR" & observe "__" in display.
d. Press number "5" or "10" for a positive offset (or press "SEnd/OFST" for a negative offset & observe "- __" in display; then press number "5" or "10."
e. Press "Sto/ENT" & observe blink & offset frequency in display.

Task 8: Perform channel scanning (non-priority):

a. Set function switch to "SQ-ON."
b. Set mode switch to "FH."
c. Set channel switch to "CUE."
d. Press "Sto/ENT" & observe "SCAn_" in display.
e. Press number "8."
f. Press P-T-T on H-250/U & observe channel number in display.

[Table continued on next page]

Table 9, continued
Components of Criterion Tasks

Task 9: Load & store TRANSEC variable into RT:

a. Set mode switch to "FH."
b. Set function switch to "LD-V."
c. Set channel switch to "MAN" (or any other channel except CUE).
d. Connect ECCM fill device to "AUD/FILL" connector.
e. Turn on fill device.
f. Turn fill device switch to "T1" or "T2" as directed.
g. Press "H°Ld/0" on RT keyboard.
h. Observe "LOAd" then "Sto t" in display, listen for beep, observe "Cold" in display.

Task 10: Load & store 2 hopsets into RT:

a. Set function switch to "LD."
b. Set mode switch to "FH."
c. Set channel switch to "MAN."
d. Connect ECCM fill device to "AUD/FILL" connector, & turn on.
e. Set fill device select switch to desired hopset (e.g., number "1") & remain in "MAN" channel.
f. Press "H°Ld/0."
g. Observe "STO _" in display.
h. Press number of desired channel ("1") & observe "Sto 1" in display.
i. Press "Sto/ENT" & observe blink in display followed by hopset number (e.g., "F001").
j. Set channel switch to channel 1 & observe "F001" in display.
k. Repeat procedure for channel 2.

Task 11: Load time-of-day into RT:

a. Set function switch to "LD."
b. Press "TIME" & observe "00" in display.
c. Press "CLR" & observe "__" in display.
d. Press mission day numbers ("01) & observe "01" in display.
e. Press "Sto/ENT."
f. Press "TIME" & observe "00 00" in display.
g. Press "CLR" & observe "__ __" in display.
h. Press time-of-day ("12 00") based on NCS master clock & observe "12 00" in display.
i. Press "STO/ENT" when master clock is at exact time (to the second).

[Table continued on next page]

Table 9, continued
Components of Criterion Tasks

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Task 12: Perform communications check (frequency hopping):

a. Set function switch to "SQ-ON."
b. Set mode switch to "FH."
c. Set channel switch to channel 1.
d. Press P-T-T on H-150/U & talk to NCS.

Task 13: Set RT for temporary storage:

a. Set function switch to "OFF."

Task 14: Cue net control station:

a. Set function switch to "SQ-ON."
b. Set mode switch to "SC."
c. Set channel switch to "CUE."
d. Turn off KY-57.
e. Key H-250/U handset for 4 seconds & release.
f. Wait 15 seconds for reply.
g. Repeat if necessary.

Task 15: Prepare to receive ERF:

a. Set function switch to "LD."
b. Set mode switch to "FH."
c. Set channel switch to "MAN" & observe "Cold" in display.

Task 16: Store ERF:

a. Observe "SIG" indicator, listen for beep, & observe hopset number in display; e.g., "HF200."
b. Press "Sto/ENT" & observe "Sto __" in display.
c. Press channel number specified by NCS for storing hopset.
d. Press "Sto/ENT," observe blink & "F200" in display.

Task 17: Perform communications check (frequency hopping):

a. Set channel switch to channel containing hopset.
b. Press P-T-T on H-250/U & talk to NCS.

[Table continued on next page]

Table 9, continued
Components of Criterion Tasks

Task 18: Zero RT, set for long-term storage, & disassemble radio set:

a. Set function switch to "Z-A" & observe "good" in display.
b. Set function switch to "STW."
c. Disconnect CX-13293/VRC cable from VINSON.
d. Disconnect W2 cable from power amplifier & RT.
e. Disconnect W4 cable from RT & AM-7239/VRC mounting adapter.
f. Disconnect H-250/U from mounting adapter.
g. Loosen RT holding clamps.
h. Pull RT & VINSON cable from mounting adapter.
i. Disconnect VINSON cable from RT.

Criterion task performance. Table 10 shows the mean performance time for each of the 18 criterion tasks included in the Criterion Test and described in the previous section. The means were calculated from the individual performance times of all students who took the test during the month of basic operator training. It is perhaps notable that the largest consumer of time other than assembling and disassembling the radio was task 3, setting up the KY-57 (VINSON). Also, considering the basic simplicity of tasks 8 (perform channel scanning), 11 (load time-of-day), 13 (set radio for temporary storage), 15 (prepare to receive ERF), and 16 (store ERF), the mean amounts of time required appear to indicate confusion among some of the students regarding appropriate operational procedures for these tasks.

The table also shows the large discrepancy between the criterion times and the actual performance times. The average time allotted for the students to complete a given task was more than three times the average amount actually required to complete the task. It is evident then that the criteria did, indeed, allow ample time and that, without revision, would serve no practical purpose in future testing. On the other hand, the mean performance times could very well serve as a rough guideline for future instruction. What is needed to complement the performance times, however, (besides replication in other classes) is corresponding data derived from the performance of highly skilled and experience operators; i.e., a sort of ideal standard that students can be made to strive for.

The average total performance time to complete all criterion tasks was about 12 minutes.

Table 10
Criterion Task Performance Times*

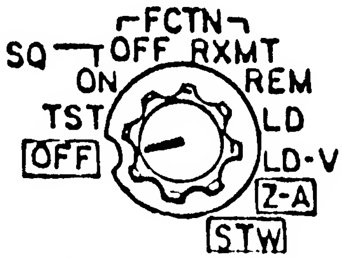
	Critical Task	Criterion Time	Mean Performance Time
1.	Assemble the SINCGARS AN/VRC-90 radio set	300	158
2.	Turn on & test radio	60	20
3.	Turn on, clear, & load TSEC/KY-57 (VINSON)	180	59
4.	Set battery condition	60	14
5.	Load manual, cue, & two single-channel frequencies	180	53
6.	Perform communications check on manual channel	120	21
7.	Set frequency offset on one channel	60	18
8.	Perform channel scanning (non-priority)	120	36
9.	Load & store TRANSEC variable	120	41
10.	Load & store two hopsets	120	46
11.	Load time-of-day	180	41
12.	Perform communications check (frequency hopping)	180	32
13.	Set radio for temporary storage	60	8
14.	Cue the net control station	120	38
15.	Prepare to receive ERF	60	17
16.	Store ERF	120	15
17.	Perform communications check (frequency hopping)	60	13
18.	Zero radio, set for long-term storage, & disassemble radio set	240	92
	Mean:	130	40

*Times are given in seconds.

SINCGARS Learning-Retention Test (SLRT)

The SLRT is a simulated hands-on, paper-and pencil test of operator skills and knowledge. It contains 34 items, which, in its current version, cover seven critical operational skills and nine critical areas of knowledge. The student performs by circling appropriate answers on items of varied formats. All of the skills items and many of the knowledge items simulate the actual physical visual aspects of the real task; e.g., the student may be asked to circle the correct answer on a multiple-choice item that has the physical appearance of one of the controls on the radio, as illustrated in Figure 1.

The function switch on the radio looks like this:



The function switch is represented like this in the SLRT:

```
           <FCTN>
 -----------------
  SQ OFF    RXMT
 SQ ON        REM
  TST          LD
 OFF           LD-V
              Z-A
           STW
```

Figure 1. Illustration of the similarity between the physical features of the radio and their representation in the SLRT.

SLRT results: skills and knowledge scores. Tables 11a and 11b show the SLRT results for 362 students who were administered the test during the month of training. Of particular note in Table 11a are the following weak spots: (a) testing the radios memories (a topic that needs special emphasis in the classroom because of the lack of appropriate labeling on the function switch and inadequate coverage in the Operator's Manual); (b) electronic-remote-fill procedures; and (c) the procedures for frequency offsetting.

The knowledge retention results shown in Table 11b also indicate a few weak areas, notably: (a) setup for remote operation (remote operation was not performed in the classroom); (b) cold start load for net members; (c) the display indication for the secondary TRANSEC variable (not stressed in the classroom); and (d) the procedure for entering the late entry mode. The last area, late entry, is especially enigmatic as presented in the Operator's Manual and as represented on the keypad of the radio. Therefore, it needs special emphasis in training.

Overall, the students achieved 71.7 percent of the points possible on the SLRT. This percentage is similar to percentages obtained in the past on the SLRT, which indicates that the current students were comparable to previous classes in post-training skill and knowledge levels. Furthermore, the present students were at some disadvantage for not having had formal NCS training as previous classes have had. Thus, 71.7 percent may be spuriously low.

Table 11a
Student Performance on the SLRT: Operational Skills

Task	Mean Percent of Perfect Score
1. Test RT memories	7.5
2. Load & store TRANSEC variable (local fill)	88.2
3. Load & store hopset (local fill)	82.2
4. Load date & time of day	83.3
5. Send hopset (ERF)	57.9
6. Receive & store hopset (from ERF)	67.9
7. Change frequency offset	64.7

Table 11b
Student Performance on the SLRT: Knowledge Retention

Knowledge Area	Mean Percent of Perfect Score
1. Single-channel frequency loading	92.5
2. Use of "STW" (stow) on the function switch	88.3
3. Setup for single-channel communications	94.2
4. NCS procedure for receiving a cue call	70.9
5. Hopset & single-channel frequency capacities of RT	76.1
6. Setup for remote operation	65.8
7. Cold start load for net member	44.2
8. Secondary TRANSEC variable display indication	27.5
9. Entering late-entry mode	56.7

<u>SLRT results: common operator performance errors</u>. The SLRT enables the tracking of operational errors after the fact because each step of task performance is recorded by the operator. It was, therefore, possible to ascertain the operational errors that were made most frequently. It was not possible, however, to produce a complete frequency distribution of errors in time for this report. Table 12 describes the errors that, because of their obvious prevalence, were among the more frequently occurring performance errors on the SLRT. It is seen that the problem areas are similar to those indicated in Tables 11a and 11b.

Table 12
Frequently Occurring Operator Performance Errors on the SLRT

Problem Area	Problem or Error Description
1. Testing the radio's memories	Very few of the operators knew how to test the radio memories, accomplished by moving the function switch to the Z-A position. Typically they would set the function switch on TST rather than Z-A. [Comment: The problem here is attributable to a human-factors design deficiency. The label on the Z-A position of the function switch bears no indication of the memory-test function. Consequently, the task should be over-emphasized in training. It was not.]
2. Loading & storing TRANSEC variable	Instead of pressing only H°Ld to "load & store" the TRANSEC variable, either both H°Ld & Sto/ENT or Sto/ENT alone was pressed. [Comment: This problem has the potentially serious consequence of erasing the primary TRANSEC variable from the radio.]
3. Loading & storing hopsets	a. Operators failed to load the hopset by pressing the H°Ld key. Instead, they would attempt to store it directly into a particular channel with Sto/ENT & a channel number. [Comment: Ideally, the radio should request the appropriate information via the display once the operator has specified the desired procedure. Since the radio is not interactive, training should emphasize the distinction between "loading" and "storing" (or "entering"), terms that can be easily misunderstood or confused with each other.]
	b. Operators pressed the Sto/ENT & channel number keys in reverse order (channel number followed by Sto/ENT) when attempting to store a hopset. [Comment: Normal procedure at a computer terminal is to type information first, then "enter" it, not vice versa. The correct procedure for storing hopsets in the radio is to press Sto/ENT first, then the desired channel number, which is opposite to customary keyboard procedures.]

[Table continued on next page]

Table 11, continued
Frequently Occurring Operator Performance Errors on the SLRT

Problem Area	Problem or Error Description
	c. Operators pressed both the H°Ld & Sto-/ENT keys prior to the channel number in attempting to store a hopset received by ERF instead of just Sto/ENT & the channel number. [Comment: This problem represents a confusion between the procedures for loading a hopset and those for a "cold start."
4. Setting date & time-of day	a. The operator attempts to enter time without first storing (Sto/ENT) the date.
	b. After storing (Sto/ENT) the date, the operator attempts to set the time without pressing the TIME key.
5. ERF Procedures	Operators set the channel switch to MAN in preparation for receiving or sending a remote fill.
6. Setting offset frequency	a. The operator enters "05" instead of "5."
	b. The operator attempts to enter an offset without first clearing the display.
	c. The operator mislocates the minus sign (SEnd/OFST key) in the series of key presses required to load a negative offset. The SEnd/OFST key is pressed either before CLR or after the offset number(s) instead of before the offset number(s).
	d. The function switch is unnecessarily set to the LD position before the offset is entered.
7. Differential functions of the Sto/ENT & H°Ld keys	The keys were frequently confused with each other, especially when "retrieving" a hopset prior to a ERF--the operator would press Sto/ENT instead of H°Ld.
8. Use of the FREQ key	The FREQ key is sometimes substituted for the H°Ld key. Apparently, the functions of the FREQ key are not sufficiently familiar to operators.

Class Size, Student-to-Radio Ratio, and Student-to-Instructor Ratio

Some of the results presented earlier were based upon observations made of the largest of the classes taught during the month of training. It had 42 students, whereas the other classes ranged in size from 11 to 26, with an average size of 21.7 (see Table 1). Because of the larger number of students in the observation class and equipment limitations, the student-to-radio ratio was much larger: 3.2 students per radio versus 1.7, on the average, in the smaller classes. The larger class had, however, the same number (3) of instructors. Hence, the question arises, How well did the large class perform in comparison with the smaller classes? To answer this question, two tests were conducted: (a) the Criterion Test scores and (b) the SLRT scores for the smaller classes were combined and compared to those of the larger class. A statistical test (Analysis of Variance, General Linear Model) was used to compare the two resultant groups on both the Criterion Test scores and the SLRT scores.

The results of the tests are summarized in Table 12, which shows the overall times for the Criterion Test and the overall percents correct for the SLRT. (As noted earlier, the overall percent correct for all classes combined was 71.1.) On the Criterion Test, the large class seemed to perform slightly better, although the result could well have been due to chance. On the SLRT, the large class again did somewhat better, and the difference was statistically significant (although not large in a practical sense). Thus, the larger class suffered no performance loss, as one might have expected; in fact, they appeared to perform somewhat better. What these results indicate is that class size, student-to-radio ratio, and student-to-instructor ratio may not be of uppermost importance for SINCGARS training, other things equal.

Table 12
Comparison of Large Class with Smaller Classes

	Large Class	Smaller Classes	Statistical Significance[a]
Criterion Test	11.3 minutes	12.0 minutes	$p < .25$
SLRT	75.7% correct	71.1% correct	$p < .02$

aProbability that the difference between the large class and the smaller classes was a chance occurrence.

Correlations among Criterion Test, SLRT, and ASVAB Scores

Table 13 lists the correlation coefficients among the overall scores on the Criterion Test, overall scores on the SLRT, and the ASVAB variables. All of the correlations are highly statistically significant ($p < .0001$). Of interest is the fact that the SLRT was moderately correlated with all of the other variables.

Table 13
Intercorrelations*

	SLRT Scores	ASVAB EL	ASVAB GT	ASVAB SC
Criterion Scores	.37	.26	.13	.26
SLRT Scores	...	.53	.41	.43

*Pearson product-moment correlation coefficients.

Criterion Test Scores, SLRT Scores, and Field Performance Scores

Operational problems in the field. Of note regarding relations among performance variables is the fact that neither the Criterion Test scores nor the SLRT scores were at all correlated with the number of problems (reported elsewhere) the operators later reported experiencing in the field during the FOT&E record-test phases. Of course, this need not have been unexpected: It was impossible to anticipate whether the top students would experience and report fewer problems because of their expertise or, precisely because of their expertise, detect and report more problems. The same was true of students at the bottom of the class.

Operator message-completion rates in the field. The successful communication of a message in the field over the SINCGARS radio is function of many things. Nevertheless, it was of interest to ask whether the Criterion Test scores and the SLRT scores would be at all related to completion rates, even though only a small set a data was available for the analysis (N = 28). The Criterion Test scores were unrelated to message completion: The Pearson correlation coefficient was .02, indicating essentially zero correlation. The correlation of message completion rate with the SLRT scores also fell short of statistical significance, although the coefficient (.25) was somewhat larger. (It was necessary to achieve a correlation of .31 in order to be significant at the .10 level.)

Miscellaneous Annotations

The miscellaneous findings reported here are based upon observations made during the training evaluation. A few involve human-factors aspects of the radio, and, as such, are not to be understood to constitute a complete list of human factors observations. Just the contrary is true; the list of human factors findings pertaining to the SINCGARS radio is long and detailed, but published in earlier reports and not, therefore, repeated here.

The following discussion is divided into content areas, each headed by a numbered paragraph.

1. Course content.

a. Training development: The SINCGARS training package contains no self-corrective or self-improving loop. That is, there appears to be no systematic, formal, effective mechanism whereby lessons learned are incorporated into future training improvements and development. Thus, some mistakes or inadequacies may be doomed to repeat themselves over and over again, and needed changes may not become incorporated into the instructional materials or procedures.

b. Net-control-station training: The basic operator course did not include formal NCS training or retransmission training. Whether or not it would be desirable to include the training as a regular part of the course has not been addressed in this report. It is only mentioned here that operators who are familiar with those procedures may very well be able to function more effectively as net members and in emergency situations where NCS functions must be taken over by a net member. A substantial number of students pointed to the lack as a shortcoming of the training (see Table 8a).

c. Prior familiarity with VINSON: The students in the large training class (Class 14; see Table 1) were asked if they had ever used the KY-57 (VINSON) before. Approximately 40% indicated that they had. The percentage who were skillful in its use, however, was probably much smaller. Whether this argues for the inclusion of VINSON training with SINCGARS training is moot; to the extent that operators are not familiar with VINSON (whether or not they should be), the inclusion of VINSON "refresher" training may be necessitated.

d. Training aids: Attention needs to be paid to the legibility of training aids such as projected overhead slides. While the large majority of the 27 view graphs used in the present course were adequately readable, a few were borderline from a distance of about twenty feet, which was about at the back row of the class. Also, a number of students made the excellent suggestion that operational procedures be listed in steps on large charts and placed at the front of the classroom during training. The operator's manuals are not, as written, good training aids (although the smaller of the two is better); therefore, the addition of other, compensating aids, such as charts and mockups, should be considered.

e. Nomenclature: The first "practical exercise" in the course required the students to identify, using the available manuals, the nomenclature associated with many components of the radio system. The students had difficulty finding all of the required information in the manuals. This exercise proved to be a very ineffective means of teaching a topic that was, later in the course, debunked as unimportant anyhow: On the last day of instruction, one of the instructors said to the class, "We could care less about nomenclature. What we care about is that you can

operate the radio." The sentiment was laudable, but the remark brings into question the utility of the practical exercise dealing with nomenclature.

f. Radio transmit distance: There is general confusion about the nominal transmit distance associated with the high power setting: Some students were told that the distance is 8 kilometers; other were told 16 kilometers. The manual says 4 to 16 kilometers.

g. Troubleshooting: Troubleshooting is not emphasized in training. When students encountered a problem, they were corrected, but rarely encouraged to track down the cause of the problem themselves through a prescribed systematic review of the situation or by conducting appropriate tests.

2. Instructional procedures.

a. Student/equipment ratio: There was apparently little or no detrimental effect of class size and low radio-to-student ratio in the classroom--at least on Criterion Test performance and performance on the SLRT. This may argue that training can be successfully conducted with larger class sizes than previously expected. However, caution must be taken to maintain order and to ensure that the radios are distributed equitable among the students. For example, it was once noted that while one of the radios was occupied by a single student, seven other students were in the back of the classroom engaged in no training related activity. Similar inequities occurred from time to time, which subtracted from the amount of hands-on time for some students. The students made frequent comments indicating their desire for a larger radio-to-student ratio and the frustration of having to share the equipment and learn at the same time (see Table 8b). It is possible that simulated radios could help to alleviated the problem if they were appropriately developed.

b. Note-taking: The students were encouraged to take detailed notes during class. One of the reasons was, of course, the shortage of manuals. It needs to be mentioned in this regard, however, that note-taking in a class such as this is an ineffective method of ensuring that the students have a record of the instructional material presented. It would be more effective to prepare simple, concise, handouts for any material that would otherwise be recorded in student notes. The handouts could be used as preparatory material for midcourse tests. In this way, all students would be exposed to the same information as well as information that did not have to go through the error-inducing process of note-taking. Note-taking has many disadvantages and few advantages that cannot be achieved by other methods. The students did not have, nor were they provided with, adequate note-taking materials (e.g., notebooks).

c. Intermediate testing: There was no effective midcourse testing to provide systematic and comprehensive feedback to students to enable them to gauge their progress through the course and their preparation for the final examination. One procedure that was attempted was only mildly successful: One student operated the radio while one or more others

looked on. The observers were instructed not to assist the operator and to raise their hands if the operator made a mistake so that one of the instructors could assist in making the appropriate corrections. Not only did the observers assist the operator, contrary to instructions, they would not point out errors to the instructors. So, while the experience may not have been without value, it did not proceed as intended.

d. Assisting instructors: Assisting instructors occasionally compete with the ongoing instruction. Students who ask them questions or who are having operational problems sometimes become engaged in conversations or activities with the assisting instructors that temporarily distract the student (and possibly surrounding students as well) from the primary instruction.

e. Practical exercises: Systematic monitoring of "practical exercises" and free-play practice periods during the course was minimal. For the most part, students did not receive systematic individualized feedback on their performance unless they requested it from the instructors or encountered a problem that prevented continued operations.

f. Structured activities:

(1) While a certain amount of experimentation on the part of the students should be encouraged (generally, it was not), some of the students, intrigued by the novelties of the equipment, moved ahead of the instructor, involving themselves in operational activities that temporarily interfered with their attention to the material being presented by the instructor. It is important, especially in larger classes, to provide structured activities that allow experimentation and practice, but also track the ongoing instruction.

(2) It was noted on several occasions that students who were invited or encouraged by the instructors to engage in hands-on practice with the radios failed to do so. All students should be required to participate fully, and hands-on time should be distributed equitably among students. Otherwise, the more aggressive students receive more practice, while the more timid receive less or, as was the case with one of the observed students, nearly none.

(3) The lack of structure in student activities is generally wasteful of instructional time, again, especially in large classes. Most of the idleness referred to earlier can be attributed to a lack of structured scenarios for student activities.

g. Lesson plans: The training materials for the instructors included official lesson plans. Adherence to the plans was not strict, except in that all material in the plans was covered. The implication here is not that the instructors should have adhered more closely to the plans, but that the plans could be more useful if they exhibited a greater sensitivity to classroom realities and provided for a much greater structuring of classroom activities.

h. Instructional setting: Instructors should be aware that the retention of skills and knowledge learned in a particular setting may suffer degradation when the student is asked to perform in a new setting. The relevance here is that the final examination (criterion testing) was conducted under very familiar circumstances for some students (same room, familiar instructor), but somewhat less familiar circumstances for others (different room, different instructor). Since the criterion testing was not used to eliminate students or to make differential assessments of them, the practical impact of such variables was nil for the FOT&E SINCGARS training. It could, however, have practical implications in other situations. An attempt should be made to vary the instructional settings and circumstances somewhat--taking account, of course, of real-world constraints--and to treat all students alike.

i. Instructional realism:

(1) For most of the course the instructors communicated over the radio in a voice loud enough to be heard without a receiver. Added realism could be achieved by using the whisper mode more frequently, so that students would have to employ the tool they are learning to use. There were many student suggestions that the course be made more realistic (see Table 8b).

(2) Some exercises with the radio should be conducted in darkness to familiarize students with the difficulties that may be encountered operating at nighttime, especially with the backpack configuration.

3. Operator's manuals.

a. Operator manual shortage: The shortage of manuals (both the 10-1 and the 10-2 versions) was unfortunate. All students should be given a personal copy of both manuals, which could then be taken home for review. No manuals were available for out-of-class use during the course. There were 13 10-1 manuals and 13 10-2 manuals in the classroom--i.e., 26 manuals for 42 students. Of course, the smaller classes, which ranged in size from 11 to 16, faired better with respect to the manual-student ratio. However, they were not given personal copies either. All classes had to share the same manuals.

b. The "10-1" operator's manual: The 10-1 manual continues to suffer from most of the shortcomings detailed in previous reports. The organization, layout, and writing are all poor. It contains grammatical errors and content errors of both of omission and commission. The index is poor. It needs extensive revision.

c. The "10-2" ("pocket") manual: The small, pocket manual is easily torn apart at the spiral binding. One of the instructors reported it was not an uncommon occurrence. This manual also needs revising, although it is, because of its reduced length, less of a problem than its larger companion, the 10-1 manual.

4. Human factors

a. Manual and cue channels: There was a noticeable confusion about the use of the manual and cue channels, due in part, it is assumed, to the ambiguous nature of the misnomer "manual," an uninformative term to say the least. Adding to the confusion is the necessity of placing the channel selector in the "CUE" position for channel scanning, which is not intuitively apparent. Also, some of the students were confused about the display messages "FILL 0" and "FILL 7." This is a human-factors problem caused by the mismatch between the labels on the channel selector and their representations in the display: The corresponding labels on the selector are "MAN" and "CUE."

b. Channel scanning: Channel scanning is a single-channel procedure. Yet the operator is required to place the mode switch on the radio in the frequency-hopping position in preparation for scanning. This requirement is logically inconsistent from the operator's perspective. This inconsistency may account in part for what appeared to be a somewhat excessive amount of time required to perform the task (see Table 10).

c. Confusing terms:

(1) The terms and abbreviations "stow," "STW," "STO," "storage," "store," "enter," "ENT," "hold," "load," "Ld," "L," "late entry," "L.E.," "full load," and "cold start" are often confused, misunderstood, interchanged, or mispronounced, by students or instructors.

(2) Instructors often substitute the term "stow" for "store" and interchange the terms "store" and "load."

(3) The abbreviation "H°Ld" on the zero key is confusing to students because the key is used to accomplished actions most often referred to as "retrieve" rather than "hold" or "load." The confusion between the terms "load" and "store" also adds to this problem. In this regard, it was not uncommon for students to press H°Ld instead of Sto/ENT when attempting to store an ERF.

(4) Many of the students were temporarily confused about the meaning of the display symbol used to represent lowercase "t." It does not look like a "t" to the untrained observer.

d. Accidental zeroizing: Students sometimes accidentally zeroed the radio (by turning the function switch to "STW") when told to turn the radio "off." As noted in the previous paragraph, there was confusion about the use of the "OFF" and "STW" positions on the function switch. The situation would be clarified if the "OFF" function were accomplished by a separate toggle not located on the overloaded function switch.

e. Battery amp hours: The meaning of the term "CALL" on the BATT/CALL key was not explained to the students. It is expected that most

of the students who went through the course take it to mean "call amp hours" or something to that effect, rather than "call remote." The display should indicate that the battery needs replacing when 12 amp hours have been reached--rather than indicating the number "12" or a higher number. A reminder such as "bAtt," "FAIL," or "bAd" might be useful.

f. Hopset loading: There appeared to be considerable confusion, at least at first, about the procedure for loading hopsets. Specifically, students erroneously believed that the channel switch had to be set on the channel into which the hopset was to be loaded. Basically, this is a human-factors problem deriving from the inconsistency in procedures for loading single-channel frequencies and frequency hopsets. The former requires the channel selector be set at the target channel; the latter does not.

g. W2 RF cables:

(1) These cables were extremely difficult to impossible to connect and disconnect from the radio end with the fingers.

(2) The design of the connectors is very poor. The insulation was pulling away from both connectors on 11 of the 13 cables in the classroom after two days of class. Whether they were that way prior to the course is unknown.

h. Power amplifier. The power amplifier needs a guide track for installation and removal to prevent accidental damage to the interface connector, which could be damaged by twisting or misaligning the amplifier during installation or removal.

i. RT Security. The metal device that is padlocked to the vehicular mount to prevent unauthorized removal of the radio is easily defeated. It needs to be redesigned.

j. Miscellaneous student observations:

(1) One student noted that the cue signal, which appears both visually and aurally, may, during periods of noise discipline, cause a breach of security. The problem would seem to be more significant in the backpack configuration of the radio.

(2) Another student, while feeding VINSON cables through the vehicular mounting adapter during installation of the radio, remarked: "Can you imagine trying to do this with somebody shooting at us? This is not GI proof!" The soldier meant that installing the cables was very difficult, which it was. The procedure caused significant problems for most of the students, especially when they attempted make the connection at the J5 connector on the radio. The pins on the connector are easily damaged.

(3) The plastic markers (label cuffs) on the VINSON cables tend to catch on the rear opening in the mounting adapter when the cable is being drawn through during installation.

Conclusion

SINCGARS training could be changed in ways that would substantially increase its effectiveness and save significant amounts of time and expense. To that end the following suggestions are offered:

1. Consideration should be given to shortening the course to a maximum of three training days rather than four. This step could probably be taken without any other changes at all. The simple requirement that the same material be taught in three rather than four days certainly does not seem unreasonable, and would, if implemented, reduce training time by 25 percent with a concomitant reduction in costs. By far the largest complaint of the students was that the course was too long (see Table 8c).

2. The use of three instructors per classroom would appear to be very wasteful. Several alternatives suggest themselves immediately: (a) Smaller, independent classes (say, of squad size) with two students per radio and one instructor. (b) Two or more smaller, related classes (two students per radio) that would be taught simultaneously, each by one instructor, in different but close physical proximity. Then students in one class could communicate with students in another class, and instructors and students could change rooms if desired for particular activities or segments of instruction. (c) Classes of about twenty students and 10 radios with one instructor.

3. Some exploration should be done into ways in which individualization of training (possibly to include modified "self-paced" or programmed approaches) could be maximized, while keeping cost and time factors at a minimum.

4. Classes should be highly structured, an element that was lacking to a considerable degree in the present course. Part of the reason for the lack of structure was the excessive amount of time allowed for a limited curriculum. There was simply nothing easily accomplished and readily available to fill the time, except continued practice sessions for which no structured activities had been planned. Those sessions were, therefore, semi-uncontrolled in character, and the usefulness of the time varied to a great degree as a function, not of the instructors, but of the students, some of whom used it beneficially while others wasted it. Practice sessions should include prescribed activities in which the students interact with the system in as realistic a manner as possible. Nets should be established that have definite missions to accomplish, and a certain amount of friendly competition should be established among the students.

5. Training aids should be expanded. Things to be considered should include an introductory video presentation, simple handouts, procedural charts, and possibly the development of some sort of simulated radios that would minimize the number of real (and costly) radios necessary for the

classroom. It is also possible that computer assisted instruction could be developed that would be beneficial, perhaps not so much in the classroom as in military units where remedial or refresher training is required for operators who have not used the equipment on a regular basis, or for new personnel rotating into the units.

6. Being substantially unchanged from earlier versions, both of the operator's manuals, the 10-1 and the 10-2, continue to need revision, especially the former.

7. The training should probably be broadened to include basic coverage of NCS tasks. A understanding of the NCS role should be useful to outstation operators in performing their own duties and in understanding the complexities of the system. Also, in emergency situations, net members would be more able to take over the role of the NCS operator. Other topics should be considered for inclusion in the curriculum: retransmission procedures, vehicular installation, data transmission, backpack configuration, remote operation, interfacing with other equipment, troubleshooting, etc.

8. The course should strive for realism, especially after the basics have already been taught, by either simulating field situations or actually taking place in the "field" (motor pools or other field-like environments).

9. There should be frequent systematic testing of all students so that they and the instructor will have objective indications of individual progress. Weaknesses can thus be dealt with at the appropriate times.

10. Viable criteria for adequate performance of critical operational tasks need to be established, not for the purpose of "failing" students who do not meet the criteria, but for use as goals toward which students can strive and as measures against which instructors can gauge student progress. The performance times presented in this report (see Table 10), represent a start in the right direction. Those figures need to be validated, but should be useful in the interim as indications of how fast the "typical" soldier will be able to perform the tasks as described in Table 9. To complement these criteria a set of performance times is needed that is based on the performance of highly skilled and experienced SINCGARS operators. The latter scores would represent a "ceiling" on performance, beyond which a normal student would not be expected to perform.

11. Specific steps should be taken in the development of SINCGARS training materials to overcome equipment limitations or shortcomings, such as human-factors problems cited here and elsewhere. Many of the common operator errors (such as those reported in Table 12) are directly attributable to human-factors shortcomings. A striking case in point is the inability of students, upon completion of training, to test the radio's memories because of the lack of labeling on the Z-A position of the function switch. The task is inherently of minimal difficulty, requiring only that the operator move the function switch into the Z-A position and retain it there long enough to confirm the test in the display. A simple but conscious emphasis by instructors on the procedure and its usefulness should eliminate the problem easily. There are many operational situations requiring this sort of corrective

instruction; they are detailed to a large extent in previous human-factors reports pertaining to the SINCGARS system.

12. The training could probably be reduced by 50 percent rather than 25 percent (or incorporate additional curriculum without a corresponding expenditure of time) if it were streamlined and improved. Achieving this goal would not seem infeasible if accompanied by the implementation of a very modest research program, designed to help achieve the goal. Any major, developing training program such as that associated with the SINCGARS system should incorporate such a self-enhancement program. The research would exercise limited experimental control over training variables so that various training formats and methods could be adequately compared and appropriate instructional materials developed. The effort would probably pay for itself many times over.